

WHAT IS CLAIMED IS:

1. A biaxial piezoelectric motor comprising:
  - a contact element, the contact element to include at least one point to contact an object to be moved;
  - a first piezoelectric driver coupled to one side of the contact element, when energized, the first piezoelectric driver to move the object in a first direction; and,
  - a second piezoelectric driver coupled to a second side of the contact element, the piezoelectric to move the object in a second direction, the first direction and the second direction to form an angle other than 180 degrees to enable movement of the object in a two dimensional plane.
2. The biaxial piezoelectric motor of claim 1 wherein the contact element is hemispherical in shape.
3. The biaxial piezoelectric motor of claim 1 wherein the first direction and the second direction are orthogonal.
4. The biaxial piezoelectric motor of claim 1 further comprising:
  - a third piezoelectric driver coupled to the contact element, the third piezoelectric driver in combination with the first piezoelectric driver and the second piezoelectric driver to enable movement of the object in every direction in a plane.

5. The biaxial piezoelectric motor of claim 4 further comprising:

a fourth piezoelectric driver coupled to the contact element.

6. The biaxial piezoelectric motor of claim 1 further comprising:

drive circuitry coupled to the first piezoelectric driver and the second piezoelectric driver, the drive circuitry to determine a desired direction and amplitude of motion for the object, the drive circuitry including a processor that computes the voltage amplitude applied to the first piezoelectric and the voltage amplitude applied to the second piezoelectric to move the object in the desired direction.

7. The biaxial piezoelectric motor of claim 6 wherein the amplitude of motion for the object is controlled by adjusting the frequency of the first piezoelectric with respect to the frequency of the second piezoelectric, a higher frequency representing an increase in amplitude of motion for the object.

8. The biaxial piezoelectric motor of claim 6 wherein the ratio of voltage amplitude applied to the first piezoelectric driver to the voltage amplitude applied to the second piezoelectric driver is equal to the ratio of the cosine of the angle formed between the desired direction and the first direction and the cosine of the angle between the desired direction and the second direction.

9. The biaxial piezoelectric motor of claim 8 wherein the ratio of amplitude of motion for the object is a ratio of frequency applied to the first piezoelectric driver to the frequency applied to the second piezoelectric driver.

10. The biaxial piezoelectric motor of claim 6 further comprising:  
a sensor to determine the position of the object and to provide feedback to the drive circuitry.

11. The biaxial piezoelectric motor of claim 6 wherein the drive circuitry and the contact elements are mounted on PCB boards.

12. The biaxial piezoelectric motor of claim 11 wherein the PCB is ceramic with conducting traces.

13. The biaxial piezoelectric motor of claim 1 wherein the contact element interacts with an opposite surface to increase friction on the object to be moved.

14. The biaxial piezoelectric motor of claim 13 wherein the opposite surface is a second biaxial piezoelectric motor.

15. The biaxial piezoelectric motor of claim 13 wherein the opposite surface is a ball bearing.

16. The biaxial piezoelectric motor of claim 1 wherein a transfer element is interposed between the contact element and the object to be moved.

17. The biaxial piezoelectric motor of claim 16 wherein the contact transfer element is a sphere, the sphere to convert stick slip motion to a rotary motion.

18 The biaxial piezoelectric motor of claim 17 wherein the sphere consists of one of a metal, a plastic, or a ceramic.

19. The biaxial piezoelectric motor of claim 17 wherein the sphere is coated with a thin layer.

20. The biaxial piezoelectric motor of claim 1 wherein the contact element contacts the object to be moved at only one point.

21. The biaxial piezoelectric motor of claim 1 wherein the output of each piezoelectric is a high frequency where the wavelength is shorter than the size of the contact element.

22. The biaxial piezoelectric motor of claim 21 wherein the interface between the piezoelectrics and the contact element is a single plane.

23. The biaxial piezoelectric motor of claim 1 wherein the biaxial piezoelectric motor is directly bonded to a PCB board.

24. The biaxial piezoelectric motor of claim 1 wherein the contact is coated with a thin coating.

25. The biaxial piezoelectric motor of claim 1 wherein the contact is textured to impart additional lateral motion to the object.

26. A biaxial piezoelectric motor comprising:

a transfer element;

a first contact element driven by a first piezoelectric, the contact element coupled to a first point on the transfer element to move the transfer element in a first direction;

a second contact element driven by a second piezoelectric, the second contact coupled to a second point on the transfer element to move the transfer element in a second direction, the first direction and the second direction to form an angle other than 180 degrees.

26. The biaxial piezoelectric motor of claim 25 wherein the direction of motion is rotational.

27. The biaxial piezoelectric motor of claim 26 wherein the transfer element is spherical.

28. The biaxial piezoelectric motor of claim 25 wherein the first direction and the second direction is orthogonal.

29. The biaxial piezoelectric motor of claim 25 further comprising:

a third contact element coupled to a third piezoelectric, the third contact element in combination with the third piezoelectric to enable movement of the object in every direction in a plane.

30. A biaxial motor comprising:

a point of contact between the biaxial motor and an object to be moved;

a delivery mechanism to deliver energy from a first piezoelectric to the point of contact, the delivery mechanism including a first piezoelectric to deliver energy to the point of contact in a first direction, the delivery mechanism including a second piezoelectric to deliver energy to the point of contact in a second direction, the first direction and the second direction to form an angle other than 180 degrees to enable movement of the object to be moved in a two dimensional plane.

31. The biaxial motor of claim 30 wherein the delivery mechanism further comprises:

a contact element coupled to the first piezoelectric and the second piezoelectric.

32. The biaxial motor of claim 31 wherein the contact element couples to an object to be moved at the contact point.

33. The biaxial motor of claim 30 wherein the contact point is on a transfer element.

34. The biaxial motor of claim 33 wherein the transfer element couples to the first piezoelectric via a first contact element and the transfer element couples to the second piezoelectric via a second contact element.